STANAG No. 4497
(Edition 1)

NORTH ATLANTIC TREATY ORGANIZATION
(NATO)

MILITARY AGENCY FOR STANDARDIZATION
(MAS)

STANDARDIZATION AGREEMENT
(STANAG)

SUBJECT: HAND-EMPLACED MUNITIONS (HEM), PRINCIPLES FOR SAFE DESIGN

Promulgated on 16 March 2000

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Major General, NOAF
Chairman, MAS

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RECORD OF AMENDMENTS

No.	Reference/date of amendment	Date entered	Signature

EXPLANATORY NOTES

AGREEMENT

1. This NATO Standardization Agreement (STANAG) is promulgated by the Chairman MAS under the authority vested in him by the NATO Military Committee.

2. No departure may be made from the agreement without consultation with the tasking authority. Nations may propose changes at any time to the tasking authority where they will be processed in the same manner as the original agreement.

3. Ratifying nations have agreed that national orders, manuals and instructions implementing this STANAG will include a reference to the STANAG number for purposes of identification.

DEFINITIONS

4. Ratification is "In NATO Standardization, the fulfilment by which a member nation formally accepts, with or without reservation, the content of a Standardization Agreement" (AAP-6).

5. Implementation is "In NATO Standardization, the fulfilment by a member nation of its obligations as specified in a Standardization Agreement" (AAP-6).

6. Reservation is "In NATO Standardization, the stated qualification by a member nation that describes the part of a Standardization Agreement that it will not implement or will implement only with limitations" (AAP-6).

RATIFICATION, IMPLEMENTATION AND RESERVATIONS

7. Page (iii) gives the details of ratification and implementation of this agreement. If no details are shown it signifies that the nation has not yet notified the tasking authority of its intentions. Page (iv) (and subsequent) gives details of reservations and proprietary rights that have been stated.

FEEDBACK

8. Any comments concerning this publication should be directed to NATO/MAS - Boulevard Leopold III - 1110 Brussels - BE

RATIFICATION AND IMPLEMENTATION DETAILS
STADE DE RATIFICATION ET DE MISE EN APPLICATION

NATION / PAYS	NATIONAL RATIFICATION REFERENCE / REFERENCE DE LA RATIFICATION NATIONALE	NATIONAL IMPLEMENTING DOCUMENT / DOCUMENT NATIONAL DE MISE EN APPLICATION	IMPLEMENTATION/MISE EN APPLICATION					
			INTENDED DATE OF IMPLEMENTATION / DATE ENVISAGEE DE MISE EN APPLICATION			DATE IMPLEMENTATION WAS ACHIEVED / DATE EFFECTIVE DE MISE EN APPLICATION		
			NAVY MER	ARMY TERRE	AIR	NAVY MER	ARMY TERRE	AIR
BE	GSA 00/26070 of/du 03/03/00	Not implementing/ Ne met pas en application						
CA								
CZ								
DA*	MA204.69-S4497/mam3-8020 of/du 03/04/98	STANAG				04/00	04/00	04/00
FR*	Decision No. 001285 DGA/DSA of/du 20/09/99	STANAG	10/99	10/99	10/99			
GE	BMVg-Fu S IV – Az 03-51-60 of/du 11/10/99	STANAG	05/00	05/00	05/00			
GR								
HU								
IT								
LU								
NL*	M98002360 of/du 27/05/98	STANAG				05//98	05/98	05/98
NO								
PL								
PO								
SP								
TU	TUDEL/STAN-1063 of/du 13/03/98	STANAG	12/99	12/99	12/99			
UK	D Stan 12/15/4497 of/du 01/05/98	STANAG	02/00	02/00	02/00			
US*+	OUSD(A&T) of/du 02/11/98	Mil Std 1911 of/du 10/07/98				07/98	07/98	07/98

* See overleaf reservations(*)/comments (+)
\+ Voir au verso réserves (*)/commentaires (+)

RESERVATIONS/RESERVES

DENMARK	Implementation of this STANAG will only take place for future procurement.
FRANCE	Paragraph 2: France excludes demolition equipment from this STANAG. Paragraph 4.c. : For all other HEMs the design principles of STANAG 4497 must be taken into account. Nevertheless, if this is technically impossible to achieve, brings unacceptable additional costs, or involves modifications to the way munitions are utilised, which are incompatible with their operational use, France reserves the right to depart from the design safety principles of STANAG 4497. These points must be justified and supported by documentation. In the safety assessment (carried out in accordance with paragraph 8), requirements which are not met must be identified and it must be ensured that the level of safety remains acceptable. These points shall be submitted to the French safety authority for approval in the course of safety certification of the munitions.
NETHERLANDS	The requirement for two independent safety features and the safety failure rate will be considered on a case by case basis.
UNITED STATES	Paragraph 7g.(5): The US will not comply with this paragraph concerning the water gap test until ratification of STANAG 4363.

DANEMARK	Le présent STANAG ne sera mis en application que pour des acquisitions futures.
FRANCE	Paragraphe 2: La France exclut les matériels de démolition de ce STANAG. Paragraphe 4.c. : Pour toutes les autres munitions mises en place à la main, les principes de conception du STANAG 4497 doivent être pris en compte. Toutefois, dans le cas d'Impossibilités techniques, de surcoûts inacceptables ou de modifications dans la mise en œuvre des munitions incompatibles avec leur utilisation opérationnelle, la France se réserve le droit de déroger aux principes de sécurité de conception du STANAG 4497. Ces points devront être justifiés et documentés. Dans l'étude de sécurité (réalisée conformément au paragraphe 8), les exigences non respectées devront être identifiées et on devra s'assurer que le niveau de sécurité reste acceptable. Ces points seront présentés à l'autorité de sécurité française pour approbation lors de l'homologation de sécurité des munitions.
PAYS-BAS	L'exigence de deux dispositifs de sécurité indépendants et le taux de défaillance du système de sécurité seront examinés au cas par cas.
ETATS-UNIS	Alinéa 7g.(5): Les Etats-Unis ne se conformeront aux dispositions de cet alinéa concernant l'essai à l'eau que lorsque le STANAG 4363 aura été ratifié.

COMMENTS/COMMENTAIRES

UNITED STATES	Paragraph 6.b(2)(a): The statement "The safety failure rate shall be less than one in a million until the intentional commencement of arming" implies that after the first manual action the failure rate can drop to some unspecified level. Suggest that the failure rate be maintained at some reasonable level (perhaps one in a million) until safe separation has been achieved. This may be difficult with grenades, but is achievable with target activated munitons.

ETATS-UNIS	Alinéa 6.b(2)(a): Dire que "le taux de défaillance de la sécurité devra être inférieur à un sur un million jusqu'au début de l'armement intentionnel de la H.E.M." signifie qu'après la première action manuelle le taux de défaillance peut chuter à un niveau non défini. Il est proposé que ce taux soit maintenu à un niveau raisonnable (éventuellement un sur un million) jusqu'à ce que la distance de sécurité ait été atteinte. Cela peut s'avérer difficile avec des grenades, mais c'est possible avec des munitions activées par l'objectif.

STANAG 4497
(Edition 1)

NAVY/ARMY/AIR

NATO STANDARDIZATION AGREEMENT
(STANAG)

HAND-EMPLACED MUNITIONS (HEM), PRINCIPLES FOR SAFE DESIGN

Annex:

A. Terms and Definitions

Related Documents:

AAP-6	NATO Glossary of Terms and Definitions
AECP-1	Mechanical Environmental Conditions to which Materiel intended for Use by NATO Forces could be exposed
AECTP-100	Environmental Testing Guidelines on Management Planning
AECTP-200	Environmental Testing-Definitions of Environments
AOP-7	Manual of Tests for the Qualification of Explosive Materials for Military Use
AOP-8	NATO Fuze Characteristics Catalogue.
AOP-15	Guidance on the Assessment of the Safety and Suitability for Service of Munitions for NATO Armed Forces
AOP-16	Fuzing Systems: Safety Design Guides
AOP-21	Fuzing Systems: Manual of Development, Characterization, and Safety Test Methods and Procedures for Lead and Booster Explosive Components
STANAG 1307	Maximum NATO Naval Operational Electromagnetic Environment Produced by Radio and Radar
STANAG 2895	Extreme Climatic Conditions and Derived Conditions for Use in Defining Design/Test Criteria for NATO Forces Materiel
STANAG 4147	Chemical Compatibility of Ammunition Components with Explosives and Propellants (non-nuclear applications)
STANAG 4157	Development of Safety Test Methods and Procedures for Fuzes for Unguided Tube Launched Projectiles
STANAG 4170	Principles and Methodology for the Qualification of Explosive Materials for Military Use
STANAG 4187	Fuzing Systems - Safety Design Requirements
STANAG 4235	Electrostatic Environmental Conditions Affecting the Design of Materiel for Use by NATO Forces
STANAG 4236	Lightning Environmental Conditions Affecting the Design of Material for Use by NATO Forces
STANAG 4239	Electrostatic Discharge, Munition Test Procedures.

STANAG 4324	Electromagnetic Radiation (Radio Frequency) Test Information to determine the Safety and Suitability for Service of Electro-explosive Devices and Associated Electronic Systems in Munitions and Weapon Systems
STANAG 4327	Lightning, Munition Assessment and Test Procedures.
STANAG 4363	Fuzing Systems: Development Testing for the Assessment of Lead and Booster Explosive Components
STANAG 4404	Safety Design Requirements and Guidelines for Munition Related Safety Critical Computing Systems
STANAG 4416	Nuclear Electromagnetic Pulse Testing of Munitions containing Electro-explosive Devices

AIM

1. The aim of this agreement is to provide general design principles and specific safety criteria applicable to Hand-Emplaced Munitions (HEMs) throughout their life cycles.

AGREEMENT

2. Participating nations agree to comply with the requirements of this STANAG and with portions of other applicable related documents imposed by this document for design and development of HEMs. This agreement is applicable to new developments initiated after ratification, subject to national ratification instructions.

DEFINITIONS

3. The term Hand-Emplaced Munition (HEM) applies to a munition that is manually emplaced at, or is hand-thrown to, a point of intended function, and that requires user action both to begin its operation and to achieve safe separation. Examples include some mines, grenades, and pyrotechnics. Other terms specific to this document are defined in Annex A.

GENERAL

4. The objective of using the requirements listed in this agreement is to optimize the safety of HEMs. The related documents listed in this STANAG should be used, when applicable, during the development of Hand-Emplaced Munitions. Adherence to and implementation of the safety design principles discussed in those documents is assumed.

a. The fuzing system requirements of STANAG 4187 are fully applicable to munitions that are NOT hand-emplaced. Whenever feasible, HEM designers are to use munition designs whose safety systems conform to the requirements of STANAG 4187. Munitions that are NOT hand-emplaced commonly use changes in levels of or changes in environmental influence exposure to permit munition enabling and arming. Because such changes in environmental stimuli usually are not available for use in arming HEMs, STANAG 4497 was developed for use when the requirements of STANAG 4187 are not feasible.

b. Representatives of the developing nation shall conduct a system safety program based on the requirements of AOP-15. The intent of that safety program shall be to ensure compliance with applicable design criteria and to control safety risk through early project attention to safety design criteria. Methods for ensuring compliance shall be based on accepted system safety analytical techniques applied as part of an iterative design process. The analyses and studies carried out under that system safety program shall consider all environmental influences, logistic conditions, and life cycle phases anticipated for the HEM.

c. Representatives of the nation developing an HEM shall conduct a methodical evaluation program of appropriate safety analyses and penalty tests to confirm that the principles for safe design given in this STANAG have been effectively implemented. Such a safety evaluation shall be conducted in accordance with international agreements and national munition safety policies in effect at that time. If the safety approving authority of the developing nation approves the HEM for service use even though the HEM is found to be less than fully compliant with the principles given in this STANAG, that approving authority shall clearly document the basis for its approval for service use.

DETAILS OF THE AGREEMENT

5. HEMs and their associated system(s) shall be designed to meet and maintain the degree of safety defined by the staff requirement for all expected and unexpected-but-credible threat and environmental exposures conceivable throughout the life cycle planned for the HEM. Compliance with the criteria listed in this STANAG shall be demonstrated by tests or be assessed by analyses or both to the satisfaction of the safety approving authority of the developing nation.

DESIGN SAFETY APPROACH

6. The following general requirements apply to the design of an HEM within the scope of this document.

a. Life Cycle Exposure Profile

In concert with the conceptual design of the HEM, an environmental and threat exposure profile shall be defined. The profile shall establish exposure conditions and limits the HEM is likely to encounter throughout its life cycle from manufacturing to use or disposal. The profile shall be used in assessing hazards associated with the HEM.

b. Analyses

The following analyses shall be conducted to identify hazardous conditions associated with the HEM. The analyses shall be conducted with appropriate timeliness in the development process to permit control of identified hazards by the most effective means.

(1) A preliminary hazard analysis shall be conducted in accordance with AOP-15 to identify the likelihood and consequences of exposure to normal and extreme-but-credible environments including combat-induced threats. That analysis shall focus on conditions and personnel actions that may occur throughout the HEM life cycle. It may be carried out on conceptual and incomplete design information. It is intended to be used in the establishment of design, test and evaluation requirements for the HEM.

(2) System and major component hazard analyses shall be carried out to identify credible single point and other failure modes and to estimate the HEM's safety failure rate. Techniques such as Fault Tree Analysis and Failure Modes Effects and Criticality Analysis may be used in performing component and system hazard analyses.

(a) Safety System Failure Rate. The HEM safety system failure rate shall be predicted for all phases of the HEM's life cycle. The safety failure rate shall be less than one in a million until the intentional commencement of arming.

(3) When the HEM contains a computing system, that computing system shall be assessed against the requirements of STANAG 4404 to identify all safety-critical functions that are controlled by the computing system. Computing systems that control safety-critical functions shall be analyzed in detail and be tested for the purpose of verifying that design weaknesses, software failures, or credible hardware failures will not compromise safety.

c. Fail-Safe Design

To the greatest extent feasible, the HEM shall incorporate design features that render the HEM incapable of attaining or maintaining an armed state and of functioning upon the failure, improper assembly, omission, or out-of-sequence operation of components.

d. Design for Survivability

The HEM shall be designed to minimize the violence of a reaction and of subsequent collateral damage when it is subjected to credible environments such as temperature extremes, shock and vibration, and fragment or bullet impact. The HEM shall use the least sensitive energetic materials available that meet the operational requirements. If possible, the use of primary explosives shall be avoided.

e. Electrical/Electromagnetic Environments

The HEM shall be designed such that, in its normal configurations, it shall not unintentionally arm, nor shall any explosive component unintentionally function, during or after exposure to: electromagnetic radiation (EMR), electrostatic discharge (ESD), electromagnetic pulse (EMP), lightning effects (LE), or power supply transients (PST). The HEM shall be tested or analyzed for the following as applicable:

(1) EMR: STANAG 4324.

(2) ESD: STANAG 4239.

(3) EMP: STANAG 4416.

(4) LE: STANAG 4327.

f. Compatibility of Materials

Explosive components shall meet the material compatibility requirements of STANAG 4147. All materials shall be chosen to be compatible and stable so that under all credible life cycle conditions, none of the following shall occur in an unarmed HEM:

(1) Premature initiation.

(2) Dangerous exudation or ejection of material.

(3) Deflagration or detonation of the lead or booster.

(4) An increase in the sensitiveness of explosive train components beyond the level appropriate for service use.

(5) Compromise of safety or sterilization features.

g. Design for Demilitarization and Disposal

To the extent feasible, the use of toxic or environmentally hazardous materials shall be avoided, not only in the design of the HEM, but also in the processes and products associated with manufacture, operation, maintenance and disposal of HEMs. When the use of toxic or environmentally hazardous materials is not avoidable, the least hazardous materials shall be used.

h. Human Factors Engineering

The HEM design shall emphasize human factors engineering to eliminate or control hazards associated with manual operations.

(1) Design Simplicity. The design of the HEM shall be as simple as possible to minimize operator error.

(2) Design Ruggedness. The design of the HEM shall be rugged enough to permit exposure of the HEM to the handling environments and stresses anticipated in its life cycle with no unacceptable degradation of its safety system.

(3) HEM Assembly and Setting. The HEM shall be designed so that it cannot be assembled in the armed condition or in a condition that compromises the intended level of safety. Where disassembly is a requirement, the design shall be such that the HEM may be dismantled safely and be capable of reuse unless otherwise specified by operational requirements. If the non-armed or armed condition of the HEM is to be checked or set after assembly of the HEM, such checking or setting shall be positive and unambiguous, and shall not degrade safety.

(4) Manually Operable Safety Features. Manually operable features critical to system safety shall be designed to minimize inadvertent or unintended operation. Unless otherwise specified in requirements documents, operation of those features shall be reversible.

(5) Operational Status Indicator. The HEM shall positively indicate its operational status in a manner that is compatible with the intended environments where the operational status will be checked. The operational status indicator shall discriminate between safe and any lesser condition of the HEM's safety system and shall provide unambiguous notification to the observer. Indicator failure shall not result in a false non-armed condition indication.

i. Design for Quality Control and Inspection

The HEM design shall be documented to facilitate application of effective quality control and inspection procedures. Design characteristics critical to safety shall be prominently identified to assure that designed safety is not compromised.

DETAILED DESIGN REQUIREMENTS

7. The following detailed requirements shall apply to all HEM designs

a. Safety Features

The safety system of an HEM shall contain at least two independent safety features, each of which shall prevent unintentional arming. Two of the safety features shall each require separate, distinct, sequentially ordered and verifiable actions to commit the HEM to arm. After the first action is taken, the HEM shall be capable of being restored to its original condition.

b. Arming or Firing-Control Delay

HEMs shall incorporate a positive feature to permit the attainment of safe separation. An arming delay provides the highest level of safety and shall be used wherever feasible. If operational or functional requirements dictate, and with prior approval of the safety approving authority of the developing nation, a fail-safe firing-control delay may be used to obtain safe separation.

c. Stored Energy

The HEM shall not use stored energy for enabling or arming if sufficient energy can be derived from environments present only during or after HEM deployment. If sufficient energy cannot be so derived, stored energy may be used with the following restrictions:

(1) Installation of any stored energy component(s) into the HEM shall be delayed as long as feasible in the manufacture to target or disposal sequence, and

(2) The design of the HEM shall prohibit release of the stored energy except as a result of at least two user actions performed in a specific sequence.

Examples of stored energy are batteries, charged capacitors, compressed air devices, explosive actuators, and loaded springs.

d. Electrical Firing Energy Dissipation

For electrically initiated explosive trains in HEMs, the design shall include a provision to dissipate accumulated firing energy after expiration of the munition's armed life or fuze system failure, or whenever the HEM is returned to the non-armed condition. The means of dissipation shall be designed to preclude common-mode failures. The period within which dissipation occurs shall be acceptable to the national safety approving authority.

e. Sterilization

Unless precluded by the staff requirement, the design of the HEM shall be such that it will self-sterilize. Self destruction may be an acceptable method of sterilizing an HEM that has been properly armed.

f. Explosive Ordnance Disposal (EOD)

Features shall be incorporated in the HEM that facilitate its being rendered safe by EOD tools, equipment and procedures, even if sterilization or self-destruction features are incorporated.

g. Explosive Materials

Explosive compositions and materials shall be selected for use in HEMs in accordance with the following paragraphs.

(1) Assessment and Qualification of Explosives. Primary, lead, booster, and main charge explosive compositions shall be assessed and qualified in their design role in accordance with the requirements of STANAG 4170.

(2) Safety in Storage and Use. Explosive compositions shall be chosen so that the HEM remains safe under the specified conditions of storage and use throughout the service life cycle.

(3) Change of Sensitiveness. The sensitiveness of explosive compositions shall not increase beyond the level at which they are approved for service use.

(4) Qualification and Sensitiveness of Lead and Booster Explosives. Only those explosives qualified in accordance with the requirements of STANAG 4170 as acceptable lead or booster explosives shall be used in a position leading to the initiation of an HEM's high explosive main charge without interruption. The explosive material used in HEM fuzing systems shall not be altered by any means likely to increase its sensitiveness beyond the level at which the material was qualified.

(5) Assessment of Explosive Components. Lead and booster explosive components in HEM fuzing systems shall meet the requirements of STANAG 4363.

h. Interrupted Explosive Trains

When the HEM explosive train contains primary explosives or explosives other than those allowed by paragraph 7g.(4), the train shall be interrupted and the following requirements shall apply:

(1) Under all specified environmental conditions or combination of conditions other than those under which a fuze is designed to function, at least one interrupter (barrier, shutter, slider, rotor) shall isolate explosives that do not meet the requirements of STANAG 4170 as lead or booster explosive from subsequent elements of the explosive train. The interrupter shall be directly mechanically locked in the safe position by at least two independent safety features of the fuzing system until the intended start of the arming sequence.

(2) The interrupter shall be designed to prevent an explosive event propagating to an acceptor explosive element beyond the interrupter prior to the intentional removal of that interrupter.

(3) If the primary explosive of an HEM is positioned such that safety is completely dependent upon the presence of an interrupter, the HEM shall include positive means that prevent fuzing system assembly if the interrupter is excluded or if the interrupter is in an unsafe position.

(4) The effectiveness of explosive train interruption shall be determined by techniques given in STANAG 4157.

i. Non-interrupted Explosive Trains

When the explosive train of an HEM contains only acceptable lead and booster explosives qualified in accordance with the requirements of STANAG 4170, no explosive train interruption is required. For such a non-interrupted explosive train, at least two independent energy interrupters — each controlled by an independent safety feature — shall prevent stimulus equal to or in excess of the initiator's maximum no-fire stimulus from reaching the initiator until the required arming delay or fail-safe firing control delay is completed. The HEM design shall preclude arming if any energy interrupter malfunctions, is absent, or is incorrectly installed.

j. Electrical initiator sensitivity - The initiator for an electrically-fired, non-interrupted explosive train in an HEM:

(1) Shall be qualified to specific test procedures and pass/fail criteria established or approved by the national safety approving authority.

(2) Shall not be capable of being detonated by any electrical potential of less than 500 volts applied directly to the initiator.

(3) Shall not be capable of being initiated by any electrical potential of less than 500 volts when applied to any accessible part of the HEM after final assembly.

k. Assembly. Where HEM safety is primarily achieved by separate storage and handling of the main charge and the initiating system explosives, such separation shall be maintained until on-site assembly and mating shall be delayed as late as possible in the assembly process.

SAFETY ASSESSMENT AND APPROVAL

8. HEMs shall be assessed and approved for safety and suitability in accordance with AOP-15.

a. Assessment

Assessment shall be a judgment made by the safety approving authority of the developing nation based upon consideration of the results of all analysis and testing results. In making the judgment, the results of analyses, developmental testing, testing of subassemblies of the HEM and tests performed for reasons other than safety, such as for obtaining performance and reliability data, shall be considered.

b. Approval

For all new or altered HEM designs, and for new applications of existing designs, representatives of the developing agency shall obtain documented concurrence from its national or service safety approving authority that the design of the HEM satisfactorily complies with this STANAG and that the safety risks associated with the service use of the HEM are tolerable.

IMPLEMENTATION OF THE AGREEMENT

9. This STANAG is considered implemented by a nation when that nation has issued instructions all future Hand-Emplaced Munitions procured for its forces will be designed in accordance with this agreement.

TERMS AND DEFINITIONS

1. Terms defined in AAP-6, the AC/310 Glossary and referenced STANAGs shall be used in this document. Terms specific to this document are defined as follows:

a. Armed

(1) An HEM is considered to be armed when any firing stimulus can produce HEM function.

(2) An HEM employing explosive train interruption is considered to be armed when the position of the interrupter(s) is ineffective in preventing propagation of the explosive train with a probability equal to or exceeding 0.005 at a confidence level of 95 percent.

(3) An HEM employing a non-interrupted explosive train is considered to be armed when the stimulus available for delivery to the initiator equals or exceeds the initiator's maximum no-fire stimulus.

b. Arming delay The time elapsed from final commitment to the arming process until the armed condition is attained.

c. Booster and lead explosives Booster and lead explosives are compounds or formulations used to augment and transmit detonation, respectively.

d. Credible environment An environment to which a device may be exposed during its life cycle (manufacturing to target or disposal). Credible environments include, but are not limited to, electromagnetic fields, line voltages, heating and cooling to temperature extremes, humidity, vibration, shock and pressure due to drops, bullet and fragment impact and nearby detonations. Combinations of environments that can be expected to occur must also be considered within the context of credible environments.

e. Credible failure mode A failure mode that has a reasonable likelihood of occurring.

f. Deployment The actions that are required to prepare and use a Hand-Emplaced Munition.

g. Demilitarization The act of removing or otherwise neutralizing the military potential of a munition in a safe, non-toxic, cost effective, practicable and environmentally responsible manner.

h. Disposal The tasks, actions or activities performed on no longer required munitions to destroy, recycle or otherwise redistribute the residual materials in a safe, non-toxic, cost effective, practicable and environmentally responsible manner.

i. Enabling The act of removing or deactivating one or more features designed to prevent arming, thus permitting arming to occur subsequently.

j. Environment A specific physical condition to which the munition may be exposed.

k. Explosive train The detonation or deflagration train (i.e., transfer mechanism), beginning with the first explosive element (e.g., primer, detonator) and terminating in the main charge (e.g., munition functional mechanism, high explosive, pyrotechnic compound).

l. Firing-control delay The time elapsed from achievement of the armed condition to the time when controls on the delivery of a firing stimulus are removed.

m. Function An HEM "functions" when its main charge produces an explosive output.

n. Hand-Emplaced Munition (HEM) A munition that is manually emplaced at, or hand-thrown to, the point of intended function, and requires user action both to begin its operation and to achieve safe separation.

o. Initiator A device capable of directly causing functioning of the explosive train.

p. Maximum no-fire stimulus (MNFS) The stimulus level at which it is known that the initiator will not fire or unsafely degrade with a probability of 0.995 at a confidence level of 95 percent. Stimulus refers to the characteristic(s), such as current, rate of change of current (di/dt), power, voltage, or energy, that is (are) most critical in defining the no-fire performance of the initiator.

q. Primary explosives Sensitive materials used in primers and detonators to initiate the explosive train. Primary explosives are sensitive to heat, impact and friction, and undergo a rapid reaction upon initiation.

r. Render safe To preclude explosive functioning through the application of special interruption or separation techniques and tools.

s. Safe separation A physical condition or state within the space between the HEM and friendly personnel and equipment that provides an acceptable level of risk from the hazards of the munition functioning.

t. Safety failure A failure of the HEM to prevent unintentional enabling, arming or functioning.

u. Safety system The aggregate of safety features and devices of the HEM and the procedures associated with its use that eliminate, control or mitigate hazards from the HEM throughout its life cycle.

v. Single-point failure A safety system failure due to the inaction or incorrect action of any individual feature of the design.

w. Sterilization A planned, programmed process that renders the HEM permanently incapable of activating energetic materials after specified events and time when the munition has served its useful purpose or is no longer capable of functioning as designed.

x. System Safety Program The combined tasks and activities of system safety management and system engineering implemented by acquisition project managers.